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Bioenergy production from agri-industrial biomass residues

a consequential LCA

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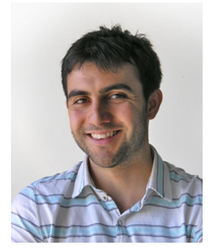
Bioenergy production from agri-industrial biomass residues: a consequential LCA



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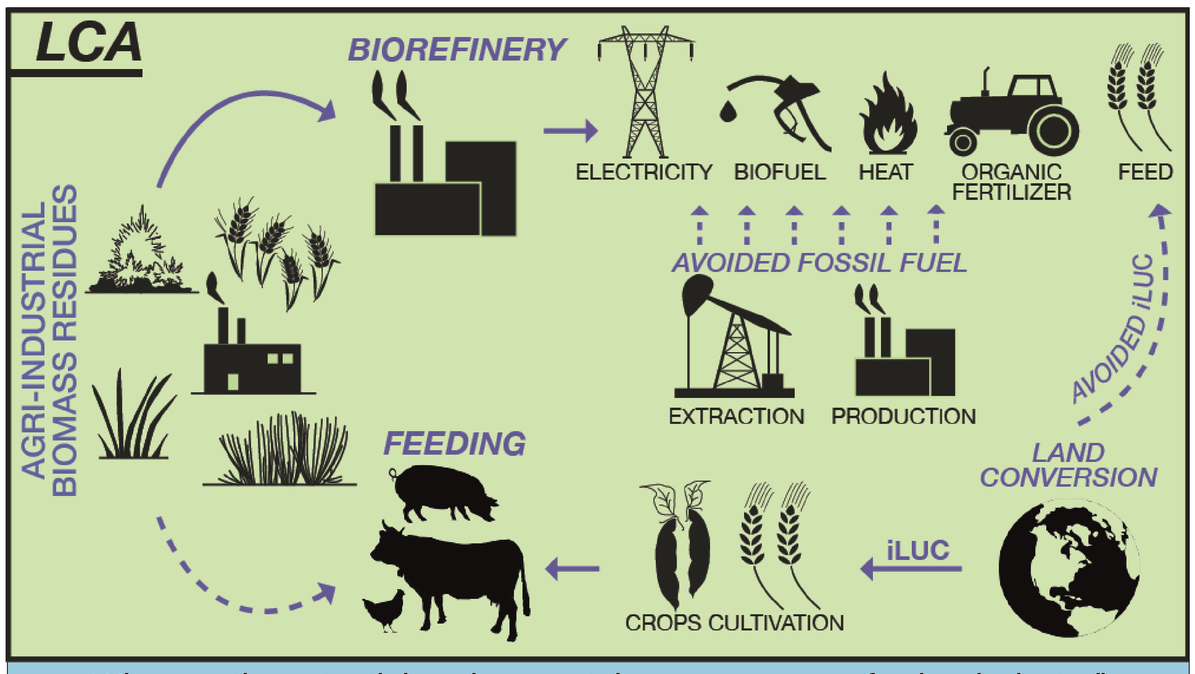
Intro

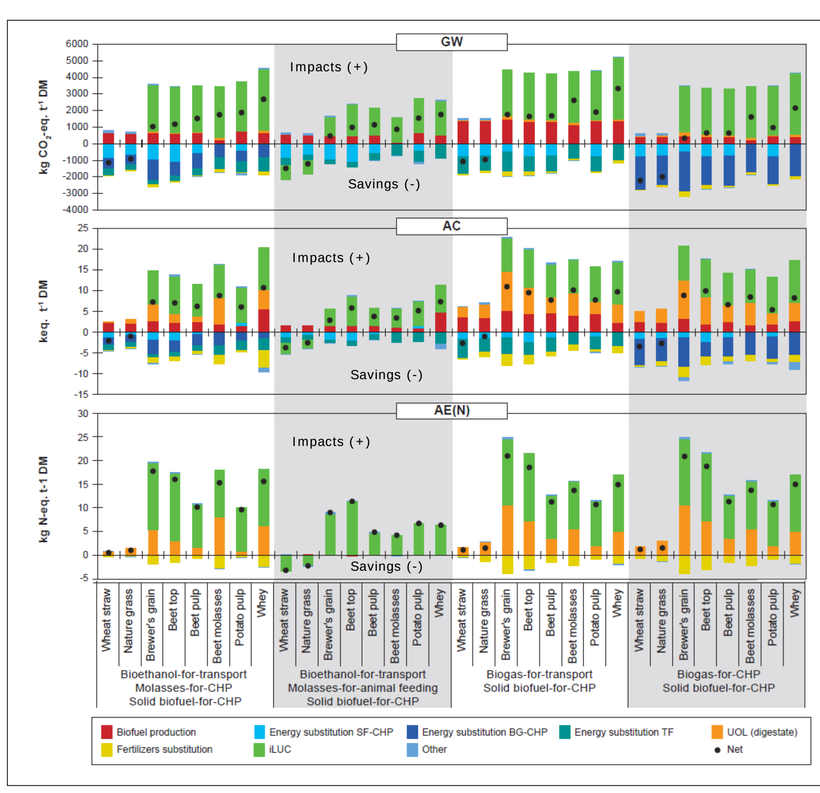
Biofuels from residues (of industrial and agricultural production) promise sustainable bioenergy and greenhouse gases mitigation. However, many studies tend to forget that these biomasses are today used for specific purposes (e.g., feeding). Thus, their use for energy may trigger an increase in the international demand of feed products that may finally induce an expansion of cropland into other ecosystems (and/or an intensification). Failing to account for these consequences may lead to results that misrepresent the actual environmental impacts.



What are the potential environmental consequences of using (selected) biomasses for bioenergy production?

Materials and method

Tools	Consequential LCA with biochemical model (integrated)
Functional Unit	1 metric **tonne** of biomass (dry basis)
Geographic & time scope	Europe **EU27** (time scope: 2015-2030)
Assessment method	ILCD-recommended: global warming (**GW**), acidification (**AC**), aquatic eutrophication (**AE**)
Biomasses investigated	Whey, brewer's grain, wheat straw, nature grass, beet molasses, beet top, beet pulp, potato pulp
Scenarios	I) Bioethanol production; molasses-for-biogas (CHP) II) Bioethanol production; molasses-for-feed III) Biogas-for-transport (PSA upgrading) IV) Biogas-for-CHP All scenarios involve use of residual solids for CHP



Impact contribution

iLUC cancels savings from fossil fuel substitution

iLUC impacts also affect AC and AE(N)

Biomasses

Straw and grass (from nature) most suitable substrates for bioenergy

Scenarios

Biogas-for-CHP best conversion pathway

CHP: combined heat and power
PSA: pressure swing adsorption

Marginal regions
Responding to an increased demand by increasing production and export (future)

Share of **intensification** and **expansion** for each region (future)

Increased fertilizers use due to intensification (future)

Carbon losses from ecosystems conversion

iLUC model

Deterministic approach based on simplified modeling of future agricultural markets

Maize

Expansion: 0.57 kg CO_2-eq. kg^{-1}

Intensification: 0.18 kg CO_2-eq. kg^{-1}

Soybean

Expansion: 2.9 kg CO_2-eq. kg^{-1}

Intensification: 0.01 kg CO_2-eq. kg^{-1}

Conclusion

General
Residues with high nutritional value should be preferably used for feed

iLUC is the most important contributor to the induced impacts

Best biomasses
Straw and grass promise the highest environmental savings (no competition with feed involved)

Best scenario overall
Production of biogas (for CHP) because of higher efficiencies

Best scenario for transport fuel
Bioethanol appears better than biogas (considering PSA upgrading)